

ART. XIII.—*The Entomogenous Fungi of Victoria.*

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I.

INTRODUCTORY.

Entomogenous Fungi, or fungi parasitic upon insects, have not hitherto received the attention in this colony which their importance deserves. Only eleven species are recorded for Australia, and six of these belong to Victoria, and yet there are quite a number awaiting the attention of the patient investigator. Dr. Cooke, in his *Handbook of Australian Fungi*, and in his popular volume on *Vegetable Wasps and Plant Worms*, has given us a more or less full account of these; but to anyone willing to take up the subject, there is a wide field for extended observation and description on the spot. We have attempted a beginning by way of extending our knowledge in this fascinating region, and trust that mycologists and entomologists may combine in unearthing the numerous forms of Entomogenous Fungi, which seem to flourish unrecorded in our midst. The subject has a dual aspect, as the name denotes. There is the entomological side in which the insects attacked by fungi are considered, and the mycological side in which the fungi attacking the insects are studied. To do full justice to the subject, both sides have to receive attention, the nature and habits of the insect being necessary for the proper understanding of the life-history of the fungus, and the fungi themselves vary according to the habits of the insects attacked. One of us is mainly responsible for the mycological portion, while the other has made careful study of the entomological part.

In addition to the entomological and mycological aspect, there is also an economic one, for apart altogether from the scientific investigation of these fungus-bearing insects and insect-destroying fungi, the subject has very important practical bearings. Every one is familiar with the common house-fly, transfixed to the

window pane or other smooth surface, with a white halo around the body, caused by the fly-mould known as *Empusa Muscae*, Cohn; and the muscardine or silk-worm disease is also well known, whereby the silk-worms become mummified, as it were, and so hard as to snap when bent. This is caused by a white mould known as *Botrytis Bassiana*, Bals., which fills, absorbs and destroys the interior of the caterpillar, and appears on the surface as a woolly covering. It would be out of place here to pursue this subject further, but it may be noticed that the coccus of the orange, the locust, and the aphides or plant-lice have all their parasitic fungi, and it has been proposed in the case of the latter to use the fungus for reducing their numbers. *Botrytis tenella*, Sacc., is known to be very destructive to the larvæ of the cockchafer (*Melolontha vulgaris*) which is recognised in Britain as the most injurious of beetles to the agriculturist; but, perhaps, the most striking instance is that of the mealy isaria (*Isaria farinosa*, Fries.), which is a parasite of the *Cochylis ambiguella*, or raisin-worm as it is commonly called, and after the phylloxera, is one of the most destructive insects to the vine. M. Duchartre drew particular attention, in the Academy of France, last year to a communication from MM. Sauvageau and Perrand recording experiments on the destruction of the insects by means of the spores of the parasitic fungus. In the course of a few days all the larvæ became infected with the fungus and were mummified by it. Similar experiments tried in the vineyard gave a mortality of fifty per cent., and the spores were simply mixed with water and sprayed upon the vines. This pitting of nature against itself opens up a wide field for the destruction of injurious insects, as well as of other pests.

Even the element of romance is not wanting in connection with some of these forms, giving rise to wonderful tales of the transformation of plants into insects, and *vice versa*. The famous Chinese plant-worm *Cordyceps sinensis*, Berk.) is mentioned by Dr. Pereira in his *Materia Medica** as "summer plant, winter worm," and is reputed to possess wonderful medical properties. The whole subject is teeming with interest, and well deserves attention from the biological point of view.

* *Materia Medica*, vol. ii., 51 (4th ed.), 1853.

SPECIES RECORDED FOR VICTORIA.

At present there are not many species of Entomogenous Fungi recorded as belonging to Australia. There are eleven species belonging to six genera altogether, and of these six species are found in Victoria, classified as follows:—

Group—Pyrenomycetes.

Order—Hypocreaceæ.

1. *Cordyceps entomorrhiza*, Fries.—Larvæ of insects (*Lepidoptera*).

1A. *Cordyceps entomorrhiza*, var. *Menesteridis*, Berk. and Muell.—Larva of *Menesteris laticollis*.

2. *Cordyceps Gunnii*, Berk.—Larva of some *Cossus* or *Hepialus*.

3. *Cordyceps Tylori*, Sacc.—Larvæ of insects.

Group—Phycomycetes.

Order—Entomophthoraceæ.

4. *Empusa Muscae*, Cohn.—Bodies of dead house-flies (*Musca domestica*) and other dipterous insects.

Group—Hyphomycetes.

Order—Stilbeaceæ.

5. *Stilbum Formicarum*, Cooke and Mass. — Dead ants (*Formica*).

6. *Isaria Cicadae*, Miq.—Cicada.

In addition to the one described in this paper, several are awaiting determination, and very probably the number will be considerably added to when careful search is made for them.

LITERATURE AND REFERENCES.

The literature referring to the preceding species is rather scanty, and may be given in its entirety:—

1. Berkeley (M. J.)—"On some Entomogenous Sphæriæ." Hook, Lond. Journ. Bot. II., 1843.

Cordyceps Tylori is described and figured.

2. Berkeley (M. J.)—"On some Entomogenous Sphæriæ." Hook, Lond. Jour. Bot. VII., 563, 1848.

C. Gunnii noted.

3. Berkeley (M. J.)—"On some Entomogenous Sphæriæ." Jour. Linn. Soc. I., 1856.

Cordyceps Gunnii and *C. Tylori* mentioned.

4. Berkeley (M. J.)—"Gardener's Chronicle." 791, 1878.
Description of *Cordyceps Menesteridis*.
5. Cooke (M. C.)—"Australian Fungi." Grev. XVIII., 8, 1889.
Description of *Stilbum Formicarum*.
6. Cooke (M. C.)—"Handbook of Australian Fungi." London, 1892.
Contains a technical description of all the Victorian species, with the exception of *Cordyceps Taylori*.
7. Cooke (M. C.)—"Vegetable Wasps and Plant Worms." S.P.C.K., London, 1892.
This is a popular account of fungi parasitic upon insects, and may be taken as a record of all known up to date.
8. Saccardo (P. A.)—"Sylloge Fungorum," I.-X. vols. Padua, 1882-92.
Contain description of all known fungi, including those of Australia.
9. Tisdall (H. T.)—"A Curious Fungus." Viet. Nat. VI., 1889.
Species of *Cordyceps* growing from an ant (*Formica corisobrina*) and found by Mr. C. French, F.L.S.
10. Tisdall (H. T.)—"On a species of *Isaria*." Viet. Nat. X., 1893.
Found on a cocoon supposed to be that of the moth, *Darala ocellata*.

NOTES ON LIFE HISTORY OF INSECT.

ONCOPTERA INTRICATA, Walker.

1. Ova.

Ova, taken from ovary, smooth, yellowish-brown, oval, about .6 mm. diameter.

2. Larva.

Length, $5\frac{1}{2}$ cm.

Head, black and polished.

Thoracic segments, black and hairless. First segment, a plain indurated collar. Second and third, plated with conspicuous, polished, chitinous prominences, arranged transversely.

Abdominal segments, nearly hairless, greenish-black with the exception of the tenth or terminal segment, which is distinctly black and polished.

The first and second are encircled by eighteen small rounded chitinous studs; the third, fourth, fifth, and sixth segments have each twelve; the seventh and eighth have sixteen; and the ninth has fourteen similar studs.

Habits.

The larva appears to be strictly nocturnal in its habits, and is usually found in low-lying country.

During the day time it hides in a little tunnel-like nest, made amongst the roots of a grass tussock. In connection with the nest the insect bores a vertical shaft, some six or eight inches deep, down which it retreats when alarmed.

Prior to its pupation, which takes place in July or August, the larva makes a vertical addition to its shaft, extending it upwards for an inch or two above the surface of the ground.

Specimens of these extensions are on the table, and may be seen to consist of a silk tube, 8 mm. in diameter, strengthened by an outer covering of grass, varying considerably, both in quantity of material, and mode of construction.

3. Pupa.

Red-brown, thorax and wing-cases darker, 25 × 6 mm., cylindrical, terminating abruptly.

When touched it shows great irritation and wriggles violently.

Ventral side of abdomen furnished with about thirty bristles, 3 mm. long, arranged nearly at right angles to the body, in three longitudinal lines, one median and two lateral.

The eighth segment projects slightly on the ventral side, bearing a hardened plate, set downwards at an angle of 45° with the body.

This organ, with the bristles on the ventral, and the adminiculæ on the dorsal surfaces, are probably of

use to the pupa in working its way from its underground retreat to the surface when about to emerge.

4. Imago.

Oncopera intricata, Walk. (*Oncopera intricata*, Walk).
Bombyces, 1559.

Hepialus fasciculatus, ib. Char. Und. Lep. (1869).

Oncopera intricata, Meyr. Proc. Linn. Soc. N.S.W., 1124
(1889).

Mr. Meyrick gives the following description of the insect :—

“Male, 31-41 mm.; Female, 48 mm.

“Head, antennæ, thorax and abdomen, fuscous or ochreous
“fuscous.

“Forewings sub-oblong, posteriorly somewhat dilated,
“costa slightly arched, apex rounded, hindmargin
“rounded obliquely, continuously with inner margin
“ochreous, ochreous brown, slaty-grey, or dark fuscous ;
“generally more or less distinctly marbled with
“irregular paler or whitish markings, including
“rounded darker spots, sometimes marked with
“blackish, but these markings are sometimes wholly
“confused or obsolete ; a pale oblique mark from
“inner margin near base, margined on each side with
“blackish, is generally conspicuous, but sometimes
“obsolete ; cilia with basal half ochreous brown,
“terminal half white, sharply barred with dark
“fuscous.

“Hindwings rather dark fuscous ; costa in male suffused
“with whitish ochreous or yellow ochreous, cilia as in
“forewings.

“A very variable moth, but the basal mark is a good
“characteristic.

“Posterior tibiæ in the male have long curved tufts of
“hair, rising from above near base, and lying along
“abdomen.”

The perfect insect appears from the middle of September to the end of October, flying rapidly over the grass during the evening.

SYSTEMATIC DESCRIPTION OF FUNGUS.

ISARIA ONCOPTERÆ, McAlp. (n.s.).

This fungus attacks the larvæ of *Oncoptera intricata*, Walk. About twenty specimens were found near Melbourne, between August and October, inside the grassy tubes made by the larvæ, and in every case either on a level with the surface, or above it. All the infected larvæ observed were nearly full grown and dead, but in no instance were they found dead below the surface of the ground, although many tubes were examined, the larvæ being always alive and apparently healthy when found below the surface. The earliest stage at which the fungus was apparent was when it had killed the grub and filled its body with a mass of soft pithy mycelium of a pale yellowish colour, and covered the outside with a layer of ochrey down, consisting of hyphæ, and having no spores visible. In a day or two, when the specimen was kept in a moist atmosphere, little white processes burst through the skin, irregularly all over the body, increasing rapidly in length, and becoming purplish-pink, except at the apex which remained white. These processes—the stromæ—have a tendency to grow upwards, irrespective of the position of the dead larva. As many as fourteen stromæ grew from one specimen, but the average number is less. No spores could be found while the processes were at all purple in colour, but when full-grown, they turn brown, and then spores are easily discernible at and near the apex.

Isaria belongs to the group *Hyphomycetes*; but the species, parasitic on insects, are mostly conidial conditions of species of *Cordyceps*.

Cordyceps belongs to the *Pyrenomycetes*, and is generally regarded as including the conidial states, described under the form-genus of *Isaria*; but until the ascigerous stage is actually found, we prefer not to class them under that genus.

ISARIA ONCOPTERÆ, McAlp. (n.sp.).

Growing from various parts of the body, dirty brown root colour, averaging $\frac{3}{4}$ to $1\frac{1}{2}$ inches high.

Stem branched, velvety, slender, tips of branches fertile. Conidia spindle-shaped to oval, hyaline, $12\ \mu.$ x $6\ \mu.$ borne on tips of hyphæ at right angles to the stroma.

On dead larvæ of *Oncoptera intricata*.